Design of Laser Communications Module for Small Satellites

Completed Technology Project (2014 - 2018)

Project Introduction

The requirements of a nanosatellite lasercom terminal will be examined, and appropriate hardware will be identified for staged pointing control. The components to be selected include attitude control actuators (reaction wheels and magnetorquers), attitude control sensors (options include sun sensors, earth horizon sensors, magnetometers, gyroscopes, and star trackers), and a fast steering mirror suitable for the application, which has already been identified. Once the appropriate components have been identified and characterized, a 6 degree-of-freedom simulation will be completed in a Matlab/Simulink environment to model the performance of the hardware on orbit. This simulation will ensure that the desired pointing accuracies will be achieved. After verification in simulation, the attitude control hardware requires validation in a laboratory environment. The MIT Space Systems Lab has developed a 3 degree-of freedom air-bearing testbed to test the attitude determination and control subsystem of nanosatellites. By assembling a representative satellite with real hardware components, the attitude control hardware and software can be tested together by utilizing this setup. Integrating the fast steering mirror into this setup will allow a hardware-in-the-loop demonstration of the control system. The final stage of this work is focused on a successful on-orbit demonstration. CubeSats are a popular type of nanosatellite for academic applications, since their small size enables rideshare opportunities for launch. The end-to-end development of a CubeSat typically takes two years or less, and they can be launched relatively cheaply as a secondary payload. The lasercom module developed will be integrated onto a CubeSat to apply the system in practice.

Anticipated Benefits

In this project, the requirements of a nanosatellite lasercom terminal will be examined, and appropriate hardware will be identified for staged pointing control. After verification in simulation, the attitude control hardware requires validation in a laboratory environment. The final stage of this work is focused on a successful on-orbit demonstration. The lasercom module developed will be integrated onto a CubeSat to apply the system in practice.

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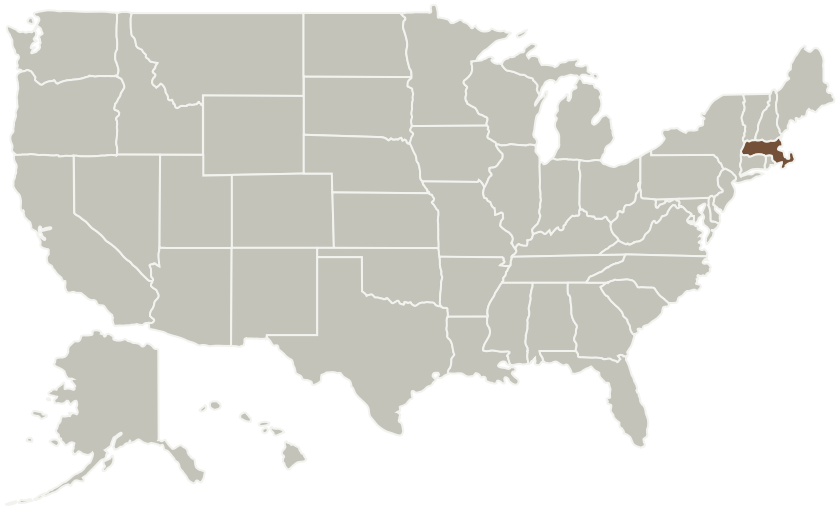
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Massachusetts Institute of Technology(MIT)	Lead Organization	Academia	Cambridge, Massachusetts

Primary U.S. Work Locations
Massachusetts

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Massachusetts Institute of Technology (MIT)

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Kerri Cahoy

Co-Investigator:

Kathleen Riesing

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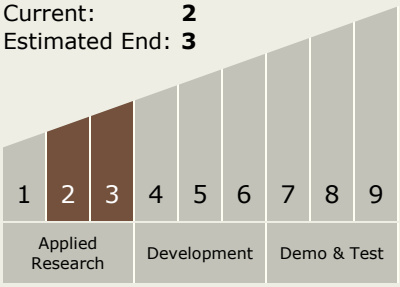
Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
  - TX17.3 Control Technologies
    - TX17.3.1 Onboard Maneuvering / Pointing / Stabilization / Flight Control Algorithms

Target Destination

Earth